Functional Assessment Using the Hydrogeomorphic Approach: Applying the Wet Pine Flats Guidebook in the Southeast

INTRODUCTION: This technical note (TN) describes recent efforts to help Corps of Engineer Districts become more familiar with the hydrogeomorphic (HGM) approach to assessing wetland functions. Demonstration projects have been initiated with selected Districts to apply newly completed HGM guidebooks to ongoing projects. This TN specifically discusses the draft *Regional Guidebook for Applying the Hydrogeomorphic Approach to Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains*. The wet pine guidebook has been applied to four different projects that vary greatly in size and complexity, including a project in the Mobile District (Figure 1).

Figure 1. Mobile District's Bill Bunkley (from left), Art Hosey, and Frank Hubiak listen to Rick Rheinhardt, principal author of the HGM Wet Pine Flats guidebook, describe the sampling protocol

BACKGROUND: One of the advantages of the Wetlands Regulatory Assistance Program (WRAP) is the opportunity it provides for cooperative efforts between scientists from the Engineer Research and Development Center (ERDC) and personnel from the Districts who serve as the Corps' front line in its interactions with the public. Cooperation and mutual benefits were the goals of a recent project designed to help Districts become more familiar with the hydrogeomorphic (HGM) approach to assessing wetland functions while at the same time providing valuable input to ERDC on the development of HGM products. With support from WRAP, a number of demonstration projects were initiated with selected Districts to apply newly completed HGM guidebooks to ongoing Regulatory projects.

Corps of Engineers regulations require that applications for wetland permits undergo a Public Interest Review that must consider what effects the project will have on "functions important to the public interest." These important wetland functions include hydrologic functions, such as storage of floodwater and protection of shorelines; biogeochemical functions, such as improvement of water quality; and biological functions, such as providing habitat for aquatic and terrestrial flora and fauna.

Procedures used to assess these functions as part of the Public Interest Review have evolved considerably through the years. Simple checklists and subjective appraisals have gradually given way to more rigorous and objective assessment procedures. Throughout the 1970s, 1980s, and 1990s there was an explosion of different assessment methods, mostly targeting wetlands in a particular state or region (Bartoldus 1999).

The first attempt to bring consistency to wetland functional evaluations in the United States was the development of the Wetland Evaluation Technique (WET) (Adamus and Stockwell 1983, Adamus et al. 1987), which rated any wetland in the country based on the probability of occurrence of 11 listed functions, plus a separate evaluation of social significance. However, experience showed that WET was not sufficiently sensitive to differences in functional levels among wetlands belonging to the same type and its probability ratings (i.e., low, moderate, or high) did not provide enough information for Corps regulators to quantify wetland impacts and evaluate mitigation proposals.

The HGM approach was developed to replace WET and to provide regulators with a rapid technique for assessing wetland functions that is applicable to a variety of wetland types over broad geographic areas (Smith et al. 1995). Development of the HGM approach has been endorsed at the national level by the Corps, Environmental Protection Agency, Federal Highway Administration, Natural Resources Conservation Service, and Fish and Wildlife Service (Federal Register 62(119): 33607-33620, June 20, 1997). However, the HGM approach is implemented at the local or regional level through the development of Regional Guidebooks that contain models to assess the functions of a particular wetland type in a defined geographic area. The output of each model is an index on a scale of 0 to 1 that reflects the actual magnitude of function in the target wetland relative to reference wetlands of the same type in the region. Thus, the Functional Capacity Index (FCI) for each function is readily used to evaluate impacts, compare project alternatives, and help design and evaluate mitigation plans.

Regional Guidebooks for applying the HGM approach are under development for selected wetland types across the country but are not yet in widespread use. Relatively few Corps regulators are familiar with HGM unless they are involved in developing a guidebook.

HGM DEMONSTRATION PROJECTS: To increase awareness of this new functional assessment method, and to provide feedback to those involved in the development of HGM guidebooks, a number of demonstration projects were initiated during FY00 with support from WRAP.

This technical note describes work done in cooperation with the Mobile and New Orleans Districts, where the draft *Regional Guidebook for Applying the Hydrogeomorphic Approach to Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains* (Rheinhardt, Rheinhardt, and Brinson, in preparation) was applied to four different projects that varied greatly in size and complexity. Three were assessments of baseline conditions at sites ranging from 12 to 147 acres. The final example was a project involving the evaluation of mitigation options for a proposed residential development that would impact several hundred acres of pine flats wetlands.

WHAT ARE WET PINE FLATS? Wet flats are precipitation-driven wetland ecosystems that may comprise up to 20 to 30 percent of the southeastern coastal plain from Virginia to Texas (Rheinhardt, Rheinhardt, and Brinson, in preparation). Wet flats occur on both mineral and organic soils, and can be dominated by hardwoods or pines. Those on organic soils are called pocosins in the Carolinas and bayheads elsewhere. Pine-dominated wet flats on mineral soils are called pine savannas and other names.

High-quality wet pine flats are open, park-like, fire-maintained wetland ecosystems in nearly level terrain (Figures 2 and 3). They typically have a sparse overstory of pond (*Pinus serotina*), longleaf (*P. palustris*), or slash pines (*P. elliottii*) and an understory consisting of native bunchgrasses and herbs. Shrubs and woody midstory plants are few or absent due to frequent burning. In the past, wildfires were caused by lightning and native people. Today, controlled burns are used in many areas to maintain the savannas and their wildlife inhabitants. Without frequent burning, pine savannas rapidly become choked with woody growth.

Figure 2. Wet pine flats have a sparse overstory of trees and mainly herbaceous understory

Figure 3. Frequent burning maintains this wet pine flat’s open, park-like condition

Fire-maintained pine savannas are noted for their extremely rich herb communities (Figures 4 and 5). A single square-meter plot may contain more than 40 different species, including highly specialized forms such as the insectivorous pitcher plants (*Sarracenia* spp.) and sundews (*Drosera* spp.).

USING THE WET PINE FLATS GUIDEBOOK: Assessing wetland functions using the HGM approach usually begins by identifying one or more assessment areas (AAs) (areas of wetland that are fairly homogeneous with respect to type and functional level) on the project site. Areas that differ greatly, say in vegetation structure or hydrologic regime, are usually delineated as separate AAs and are evaluated separately. Later, the results can be combined across AAs to produce a single evaluation for wet pine flats across the entire site.

Figure 4. High-quality wet pine flats indicator plant, pitcher plant (*Sarracenia spp.*)

Figure 5. High-quality wet pine flats indicator plant, pipewort (*Eriocaulon spp.*)

Wet pine flats are subject to various hydrologic alterations that may dictate the division of a site into different AAs. These include unculverted roadways that pond water on the upgradient side and produce a reservoir shadow on the downgradient side, or ditches that depress water tables within a certain lateral distance. Furthermore, different types of wet pine flats (i.e., bunchgrass/pine savanna, cypress/pine savanna, or switchcane/pine savanna) may be present on the same site. They must be sampled separately because model structure and the kinds of variables to be measured differ slightly among types. Time since last burning or mowing can also affect vegetation structure and may dictate separate AAs. However, despite the potential variety of site conditions, the typical Section 404 project site requires only 1-3 AAs.

In each AA, model variables are measured at three or more sampling points established at random locations. Data collection requires only 15-20 min. per point by experienced personnel. First, presence or absence of 20 indicator plant species (a pictorial guide is provided in the guidebook) is determined within a 1-m^2 quadrat and, again, within a 2-m-radius circle centered on the sampling point. Visual estimates of percent coverage of native bunchgrasses and sedges are then made in the 2-m-radius circle. Leaf-area index (LAI), which affects evapotranspiration rates in these systems, is calculated by estimating the coverage of each of five vegetation strata (i.e., groundcover, low shrubs, subcanopy, midcanopy, and canopy) and weighting the estimates according to a formula given in the guidebook. Alterations to the ground surface, such as ruts from off-road vehicles, are scored within a 50-m^2 plot. Depending upon the type of savanna involved, additional variables may include a count of small woody stems in the 50-m^2 plot, a count of pine trees within 10 m of plot center, and measurements of the distance to the nearest cypress in each of three size categories. A final variable, best determined from recent aerial photographs, is the total acreage of fire-maintained habitat of which the AA is a part.

To calculate baseline FCIs for each of the four functions considered in this guidebook, hand calculations can be done directly on the data forms or a pre-programmed Excel® spreadsheet is available at the Environmental Laboratory Web site (http://www.wes.army.mil/el/wetlands/datanal.html).

PROJECT OBJECTIVES AND LEVELS OF ANALYSIS: For many projects, the calculation of existing or baseline FCI values may be all the information that is needed. Baseline values indicate how well the target wetland functions, on a per-acre basis, relative to the most fully functioning examples of that wetland type in the region considered by the guidebook.

However, if the goal of the analysis is to compare different project configurations or alternative designs, such as to identify the least damaging project alternative, then the acreage of wetland impacts must also be taken into account. This is easily done by multiplying FCIs by the number of acres impacted to determine Functional Capacity Units (FCUs) for each function (i.e., FCU = FCI × acres). Thus, the relative impact of one project alternative over another is determined by comparing FCUs lost or gained under each alternative.

This same approach is readily extended to evaluate the adequacy of a proposed mitigation plan. The goal of no net loss of wetland function requires that project impacts must be completely compensated by the mitigation plan. Project impacts are quantified by calculating FCUs lost at the impact site due to the project. In turn, benefits of the mitigation plan are quantified by estimating FCUs gained at the mitigation site through enhancement, restoration, or creation of wetlands. As long as the wetlands on the impact site and mitigation site are of the same type, the adequacy of the mitigation plan can be determined by comparing FCUs lost to impacts with FCUs gained through mitigation.

Often there are delays in the development of wetland functions at a mitigation site due to development of wetland characteristics over time (e.g., vegetation growth and succession, development of soils). These time lags can be taken into account in the evaluation of a mitigation plan by estimating FCUs lost or gained each year over a specified time horizon or project lifetime, which might be 10, 20, or 50 years depending upon the rate of development of wetlands of that type. Thus, the adequacy of mitigation can be determined by comparing *average annual* FCUs lost and gained over the lifetime of the project. Analyses of this sort can be done readily with software available from the Environmental Laboratory.

DEMONSTRATION PROJECT 1: ASSESSING BASELINE CONDITIONS: In September 2000, Jim Wakeley and Darrell Evans of the ERDC Environmental Laboratory met with James Barlow and several of his colleagues from the Regulatory Branch of the New Orleans District to select a number of active projects on which to demonstrate and test the draft Wet Pine Flats guidebook. The group chose three projects—The Savannahs, New Town Concepts, and Bedico Creek—for which baseline assessments of wetland functions would be valuable input into the permit review process. All three sites were located in St. Tammany Parish, Louisiana, and contained bunchgrass/pine savanna wetlands in various stages of regrowth since the last fire.

The 12 acres of wetland proposed for development at The Savannahs were sampled as a single AA with three sampling points. The New Town Concepts site was divided into two AAs; the majority of the site (92 acres) was sampled with six points while a cleared powerline right-of-way (3 acres) was sampled with three. Only a portion of the Bedico Creek project area was assessed, and this portion was divided into two AAs, a north unit (22 acres, three sampling points) and a south unit (125 acres, six points). The number of sampling points allocated to each AA was determined in the field and depended on its size and the amount of variability encountered during data collection (Figure 6).

Figure 6. James Barlow and Mike Farabee (New Orleans District) and Darrell Evans (ERDC) (left to right) search for indicator plants at a project site in St. Tammany Parish, Louisiana. The angled pipe scribes a 2-m-radius circular plot

Data collection at all three project sites combined took about a day and a half, including travel time from the District office and between sites. A single sampling team was used at The Savannahs and Bedico Creek. The group split into two teams to sample New Town Concepts. Data analysis and calculation of baseline FCI values took about 2 hr using a pre-programmed spreadsheet designed for use with the Wet Pine Flats Guidebook.

Table 1 shows baseline FCI values for each project site and AA. Most of the sites were hydrologically unaltered (i.e., no significant drainage features or impediments to surface flows), so they rated fairly highly on Function 1. The powerline right-of-way at New Town Concepts scored lower due to rutting by off-road vehicles that altered surface drainage and compacted the soils. Function 2, Maintain Characteristic Plant Community, mainly reflected the time since last fire or mowing. Woody species were encroaching on most AAs, and fire-adapted herbs and native bunchgrasses were being replaced by invasive species. Function 3, Maintain Characteristic Animal Community, was determined by the quality of the plant community (Function 2) and the overall acreage of fire-maintained habitat. Most sites rated low due to recent histories of fire exclusion. Finally, characteristic biogeochemical processes (Function 4) are assumed to occur if both the hydrologic regime (Function 1) and plant community (Function 2) score highly. All AAs were given moderate scores for Function 4.

Table 1
Baseline FCIs Measured at Three Wetland Project Sites in St. Tammany Parish, LA[1]

Function	Bedico Creek		New Town Concepts		The Savannahs
	South Unit	North Unit	Main Site	Powerline Right-of-Way	
1. Maintain Characteristic Water Level Regime	0.98	1.00	0.98	0.74	0.88
2. Maintain Characteristic Plant Community	0.47	0.33	0.39	0.69	0.50
3. Maintain Characteristic Animal Community	0.45	0.13	0.14	0.20	0.16
4. Maintain Characteristic Biogeochemical Processes	0.68	0.58	0.62	0.71	0.66

[1] Based on the HGM Regional Guidebook for assessing the functions of Wet Pine Flats on mineral soils in the Atlantic and Gulf Coastal Plains.

FCIs indicate the per-acre level of function of the target wetland. Therefore, the overall impacts of each project would be determined by multiplying FCI by the number of acres impacted. This calculation yields FCUs, which can then be summed across AAs for each function. For example, the total impact of New Town Concepts for Function 2 would be estimated as the number of FCUs lost on the main site (0.39×92) plus the number lost in the powerline right-of-way (0.69×3) for a total of 38 FCUs.

DEMONSTRATION PROJECT 2: EVALUATING MITIGATION PLANS: The second demonstration project required an evaluation of mitigation options for a large residential development in Baldwin County, Alabama. The proposed Southern Pines Project would impact 240 acres of pine savanna wetlands. The developer proposed to mitigate project impacts, at least in part, by enhancing wetland functions on an adjacent 171-acre tract.

The impact area was divided into 11 AAs based on savanna type (bunchgrass/pine and cypress/pine savannas were both present), growth stage since the last fire, human disturbance, and other factors. The mitigation area was divided into nine AAs. Sampling was accomplished in June 2000 by Mobile

District Regulatory staff, including Project Manager Bill Bunkley, Art Hosey, Frank Hubiak, and Larry Godwin, along with Jim Wakeley, Chris Noble, and Darrell Evans of the ERDC Environmental Laboratory. The sampling effort was supervised by Rick Rheinhardt of East Carolina University, author of the Wet Pine Flats Guidebook (Figure 1).

After some initial orientation and training, the group split into two sampling teams and completed the field work in less than 3 days. Baseline FCI values for each AA were calculated each evening using simple spreadsheet applications. However, to assess the overall balance between functional losses on the impacted site and functional gains on the mitigation site for each mitigation option, more sophisticated software was required. The analysis was performed by Kelly Burks-Copes and Tisa Webb of the ERDC Environmental Laboratory using the Expert HGM (EXHGM) module of the Integrated Bio-Economic Planning System (IBEPS). Kelly and Tisa presented a workshop for Mobile District Regulatory staff at which mitigation options for the Southern Pines Project were discussed and analyzed with EXHGM.

Table 2 shows the assessment of baseline or pre-project conditions on the proposed impact and mitigation sites. In general, both areas scored at moderate to high levels for all functions except for maintenance of a characteristic animal community. This function only achieves high values in savannas that burn regularly. At the Southern Pines Project site, only a few areas showed signs of recent fires (e.g., assessment area M-9) and these areas were much smaller than the 250-acre threshold for optimum area of fire-maintained habitat used in the models. One important result of the assessment was that the proposed mitigation site already seemed to function at fairly high levels for most functions, which severely limited the potential gain in function that might be achieved through any of the mitigation plans.

Three mitigation scenarios were considered in the analysis, including a “No Mitigation” option (Table 3). The analysis incorporated the developer’s plans for a phased project, with 154 acres of savanna wetlands impacted in the first year of the project and another 86 acres in the fifth year. Losses and gains of wetland functions were analyzed over a 20-year project life.

In general, the analysis showed that project impacts could not be fully compensated by implementing any of the proposed mitigation scenarios on the designated mitigation site (Table 4). For only one function, Maintain Characteristic Animal Community, did the anticipated gains on the mitigation site exceed the losses on the impact site, at least for the burning and mowing mitigation options. For most functions, it would be necessary to go off-site (e.g., to a mitigation bank) to develop sufficient mitigation credits to offset project impacts. Results of the HGM assessment can also be used to estimate compensation ratios (i.e., number of acres of mitigation required to compensate fully for each acre of impacts) for each function under each mitigation scenario.

SOME PROS AND CONS OF THE HGM APPROACH: Analytical tools, such as the Regional Guidebooks being prepared to assess wetland functions by the HGM approach, help to reduce the subjectivity involved in evaluating project impacts and mitigation plans. This helps to ensure that every permit application is evaluated fairly and objectively, and reduces the reliance on subjective evaluation methods or mitigation formulas established by precedent or interagency agreement rather than by impartial analysis.

Table 2
Baseline Assessment of Wetland Functions on the Proposed Impact and Mitigation Areas, Southern Pines Project

Assessment Area	Savanna Type*	Acres	FCI			
			Water Level Regime	Plant Community	Animal Community	Biogeochemical Processes
Impact Area:						
I-1	CPS	15.0	0.50	0.99	0.22	0.70
I-2	CPS	17.1	0.87	1.00	0.22	0.93
I-3	BPS	32.7	0.84	0.33	0.13	0.52
I-4	BPS	16.9	0.84	0.65	0.18	0.74
I-5	CPS	34.4	0.94	1.00	0.22	0.97
I-6	BPS	51.7	0.86	0.68	0.18	0.76
I-7	BPS	17.3	0.86	0.68	0.18	0.76
I-8	BPS	8.8	0.90	0.67	0.18	0.77
I-9	CPS	11.0	0.81	0.57	0.17	0.68
I-10	BPS	12.9	1.00	0.90	0.21	0.95
I-11	BPS	22.5	0.84	0.06	0.06	0.23
Total		**240.3**				
Mitigation Area:						
M-1	CPS	25.2	0.76	1.00	0.22	0.87
M-2	CPS	13.4	0.84	0.94	0.22	0.89
M-3	CPS	37.7	0.94	1.00	0.22	0.97
M-4	BPS	16.8	0.86	0.68	0.18	0.76
M-5	CPS	4.6	0.86	0.93	0.22	0.89
M-6	BPS	16.2	1.00	0.90	0.21	0.95
M-7	BPS	9.7	1.00	1.00	0.33	1.00
M-8	CPS	42.2	0.84	0.74	0.19	0.79
M-9	BPS	5.6	1.00	1.00	0.45	1.00
Total		**171.4**				

*BPS = bunchgrass/pine savanna, CPS = cypress/pine savanna.

Table 3
Description of the Mitigation Options Used in the Analysis of the Southern Pines Project

Mitigation Option	Description
No mitigation	No action would be taken on the mitigation site. Woody vegetation would be allowed to develop without any fires or other manipulation, resulting in the loss of typical pine savanna herbaceous indicator plants and native bunchgrasses. The characteristic open structure of the community would be lost.
Burn	The mitigation site would be burned every 2 to 3 years, encouraging a diverse community of adapted herbs and native bunchgrasses and producing the open, park-like structure typical of fire-maintained savanna wetlands. All variables would achieve optimal values after the first two fire cycles.
Mow	The mitigation site would be mowed and cleared of brush every few years in an effort to simulate a fire-maintained system without burning. This would help maintain the park-like appearance of the savanna but would be less effective at discouraging woody growth and maintaining a diversity of fire-adapted herbs and native bunchgrasses.

Table 4
Net Gains (+) or Losses (-) in Average Annual FCUs for the Southern Pines Project Under Each Mitigation Option

Mitigation Option	Net Change in Average Annual FCUs			
	Water Level Regime	Plant Community	Animal Community	Biogeochemical Processes
No mitigation	-199.4	-91.2	-16.8	-109.4
Burn	-196.6	-41.0	116.8	-74.6
Mow	-198.2	-59.3	73.1	-85.6

On the other hand, the HGM approach, like many other assessment methods, has limitations and requires flexibility and good judgement in its application. For example, it cannot be used to compare wetlands of different types, such as pine savannas and bottomland hardwoods, because the models, variables, and reference standards are different. In addition, the HGM approach separately assesses each function, but does not address trade-offs, such as when losses of one function are mitigated through gains in another function. And finally, it makes no judgements about the relative value of wetland functions to people.

The HGM approach still leaves plenty of room for subjectivity and cannot substitute for a knowledgeable and experienced regulator. For example, an evaluation of mitigation options requires predictions of future conditions on restored wetlands and an understanding of restoration failure rates, which should be based on the regulator's experience with similar projects in the District. The goal of the HGM approach is to provide sound technical input into a decision based also on regulation, policy, and common sense.

CONCLUSIONS: The demonstrations of the HGM Wet Pine Flats Guidebook described in this bulletin were successful in that valuable information about functional capacity of Section 404 project sites was gathered quickly and efficiently, well within the time constraints imposed by the Regulatory process. Baseline evaluations of relatively uncomplicated sites (one or two assessment areas and up to about 20 acres) were accomplished in under 2 hr of field time by a single sampling team. Although larger teams were used to accommodate more people, a two-person field team would be most efficient. The only special qualifications required of investigators are familiarity with the sampling protocol and the ability to identify up to 20 species of indicator plants. Final baseline FCI values were calculated rapidly in the field with a pre-programmed spreadsheet on a notebook computer.

Functional evaluation may not be needed for the smallest wetland projects. However, the HGM Wet Pine Flats Guidebook proved to be an efficient and useful tool for providing input into the Public Interest Review of projects ranging in size from a few to several hundred acres, and in complexity from simple baseline assessments to evaluations of complex mitigation proposals.

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> Wakeley, J. S., Barlow, J. A., and Bunkley, W. R. (2001). "Functional assessment using the Hydrogeomorphic (HGM) approach: Applying the wet pine flats guidebook in the Southeast," *WRAP Technical Notes Collection* (ERDC TN-WRAP-01-04), U.S. Army Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/wrap*